

Claims

1. A method of forming a masking pattern on a surface, said method comprising the
5 steps of:
depositing using droplet deposition apparatus a plurality of droplets on to a surface
to form a masking pattern, said droplets passing through an operating zone located
between the deposition apparatus and the surface; and
controlling the local environment of the operating zone so as to control the
10 formation of the masking pattern on the surface.
2. A method according to Claim 1, wherein the formation of the masking pattern is
controlled so that the masking pattern has predetermined structural properties.
- 15 3. A method according to Claim 1 or 2, wherein the operating zone extends from the
deposition apparatus to the surface.
4. A method according to any preceding claim, wherein relative movement is effected
between the deposition apparatus and the surface so as to move said operating zone across
20 the surface during formation of the masking pattern.
5. A method according to any preceding claim, wherein the local environment of the
operating zone is controlled so as to control the coalescence of the droplets on the surface.
- 25 6. A method according to any preceding claim, wherein the local environment of the
operating zone is controlled so as to control the spreading of the droplets on the surface.
7. A method according to any preceding claim, wherein the local environment of the
operating zone is controlled so as to control placement of the droplets on the surface.
- 30 8. A method according to any preceding claim, wherein the local temperature of the
operating zone is controlled so as to control the rate of solidification of the droplets on the

surface.

9. A method according to any preceding claim, wherein the local atmosphere of the operating zone is controlled.

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10. A method according to Claim 9, wherein an at least partial vacuum is generated in the operating zone so as to substantially avoid contamination of the droplets during passage from the deposition apparatus to the surface.

10 11. A method according to Claim 9 or 10, wherein a pressure differential extending between the deposition apparatus and the surface is established in the operating zone.

12. A method according to any of Claims 9 to 11, wherein an inert or reactive gas is introduced into the operating zone during droplet deposition.

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13. A method according to any preceding claim, wherein the operating zone is locally exposed to electromagnetic radiation so as to control coalescence of droplets on the surface, thereby controlling the solidity of the masking pattern.

20 14. A method according to Claim 13, wherein the duration of the local exposure of the operating zone to electromagnetic radiation is controlled so as to control the spreading of the droplets on the surface, thereby controlling the resultant shape of the masking pattern.

15. A method according to Claim 13 or 14, wherein the intensity of electromagnetic
25 radiation is controlled so as to control the spreading of the droplets on the surface, thereby controlling the resultant shape of the masking pattern.

16. A method according to any of Claims 13 to 15, wherein the operating zone extends to the surface, and local exposure of the operating zone to electromagnetic radiation is
30 carried out subsequent to the deposition of droplets passing through the operating zone.

17. A method according to Claim 16, wherein the time period between the deposition

of droplets on the surface and said local exposure is controlled so as to control spreading of the droplets on the surface.

18. A method according to Claim 17, wherein said time period is in the range from 1 to
5 2000 ms.

19. A method according to Claim 18, wherein said time period is in the range from 50
to 300 ms.

10 20. A method according to any of Claims 13 to 19, wherein said electromagnetic
radiation is emitted from a source integral with said deposition apparatus.

21. A method according to Claim 20, wherein said electromagnetic radiation is emitted
from a plurality of sources spaced along the deposition apparatus.

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22. A method according to any of Claims 13 to 21, wherein the electromagnetic
radiation comprises at least one of ultra violet, visible light, infra red, microwaves and
alpha-particles.

20 23. A method according to any of Claims 13 to 22, wherein multiple wavelengths of
electromagnetic radiation are co-incident sequentially or in parallel on the deposited
droplets.

24. A method according to any of Claims 13 to 23, wherein the electromagnetic
25 radiation is emitted from at least one light emitting diode.

25. A method according to Claim 24, wherein the electromagnetic radiation is emitted
from an independently addressable array of light emitting diodes.

30 26. A method according to any of Claims 13 to 23, wherein the electromagnetic
radiation is emitted from a semiconductor quantum-well solid state laser.

27. A method according to Claim 26, wherein the electromagnetic radiation is emitted from an independently addressable array of semiconductor quantum-well solid state lasers.
28. A method according to any of Claims 13 to 23, wherein the electromagnetic
5 radiation is emitted from at least one light emitting polymer.
29. A method according to Claim 28, wherein the electromagnetic radiation emitted from said light emitting polymer is filtered to select a particular wavelength of electromagnetic radiation.
- 10 30. A method according to any of Claims 13 to 23, wherein the electromagnetic radiation is emitted from a microwave initiated gaseous discharge radiation source.
31. A method according to any of Claims 13 to 23, wherein the electromagnetic
15 radiation is emitted from a plurality of optical fibres.
32. A method according to any of Claims 13 to 31, wherein the electromagnetic radiation emitted is focused on the droplets.
- 20 33. A method according to any of Claims 13 to 32, wherein, subsequent to the local exposure of the operating zone to electromagnetic radiation, the deposited masking pattern is fully exposed to electromagnetic radiation so as to ensure that the deposited droplets are cured.
- 25 34. A method according to any preceding claim, wherein the distance between the deposition apparatus and the surface is controlled during droplet deposition so as to control the time taken for a droplet to pass from the deposition apparatus on to the surface.
35. A method according to Claim 34, wherein said distance is in the range from 0.5 to
30 2 mm.
36. A method according to Claim 35, wherein said distance is in the range from 0.75 to

1.25 mm.

37. A method according to any preceding claim, wherein the deposited masking pattern is imaged using imaging apparatus integral with the deposition apparatus.

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38. A method according to any preceding claim, comprising the step of controlling the surface energy of the surface prior to droplet deposition.

39. A method according to Claim 38, wherein the surface is subjected to at least one of
10 abrasion, polishing, ozone treatment, plasma exposure and surface coating prior to droplet deposition.

40. A method according to any preceding claim, using the technique of drop-on-demand printing to deposit droplets of deposition material on said surface.

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41. A method according to Claim 40, wherein the droplets are deposited from a droplet deposition printhead comprising a deposition chamber for housing said deposition material, an outlet nozzle in fluid communication with said deposition chamber, and means for ejecting droplets of deposition material from said deposition chamber through said outlet
20 nozzle.

42. A method according to Claim 41, wherein the droplets are deposited from a plurality of said printheads.

25 43. A method according to Claim 42, wherein the masking pattern is formed from a plurality of deposition materials, each deposition material being deposited from respective deposition printhead.

44. A method according to any of Claims 41 to 43, wherein the outlet nozzle is
30 selectively covered to substantially prevent entry of electromagnetic radiation into the deposition printhead.

45. A method according to any of Claims 41 to 44, wherein said nozzle is cleaned after ejection of a droplet from said deposition chamber.

46. A method according to any of Claims 41 to 45, wherein said outlet nozzle is
5 selectively covered by a nozzle shutter, said shutter comprising means for cleaning said nozzle.

47. A method according to Claim 46, wherein said outlet nozzle is cleaned by a movable wiper blade attached to said nozzle shutter.

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48. A method according to Claim 46 or 47, wherein residual deposition material removed from said nozzle by said cleaning means is transferred to a reservoir housed with said deposition printhead.

15 49. A method according to any preceding claim, wherein the surface is disposed on a flexible sheet connected between two reels, said reels being rotated to move the surface relative to the deposition apparatus.

50. A method according to any preceding claim, comprising the step of at least partially
20 removing said deposited masking pattern.

51. A method according to any preceding claim, wherein said masking pattern is a three-dimensional masking pattern.

25 52. A method according to Claim 51, wherein said masking pattern comprises a plurality of layers of deposition material, said layers being sequentially deposited on said surface.

53. A method according to Claim 52, wherein each layer has a respective shape.

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54. A method according to Claim 51, wherein said masking pattern is formed from a multiplicity of droplets deposited at a plurality of deposition sites on the surface, droplets

being deposited at each of said sites in turn.

55. A method according to any preceding claim, wherein said masking pattern comprises a solder reflow mask.

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56. A method according to Claim 55, wherein said mask is formed from one of silicone, polyimide, polytetrafluoroethylene and epoxy.

57. A method according to any of Claims 1 to 54, wherein said masking pattern is an
10 etching mask.

58. A method according to Claim 57, wherein said etching mask is formed from an organic-inorganic fluid.

15 59. A method according to Claim 57, wherein said etching mask is formed from one of epoxy, polycarbonate, silicon, polytetrafluoroethylene, polychlorotrifluoroethylene, polyimide, polyisoprene and polypropylenepolystyrene.

60. A method according to any of Claims 1 to 54, wherein said masking pattern is an
20 electrically conductive mask.

61. A method according to Claim 60, wherein said mask is formed from one of carbon-based and metal acetate-based material.

25 62. A method according to any of Claims 1 to 54, wherein said masking pattern is a decorative masking pattern.

63. A method according to any of Claims 1 to 54, wherein said masking pattern is an ion implantation mask.

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64. A method according to any of Claims 1 to 54, wherein said masking pattern is a confinement well mask.

65. A method of forming a spacer pattern on a surface, said method comprising the steps of:

depositing using droplet deposition apparatus a plurality of droplets on to a surface
5 to form a spacer pattern, said droplets passing through an operating zone located between the deposition apparatus and the surface; and

during droplet deposition, controlling the local environment of the operating zone so as to control the formation of the spacer pattern on the surface.

10 66. A method of forming a circuit pattern on a circuit board, said method comprising the steps of:

depositing using droplet deposition apparatus a plurality of droplets on to said circuit board to at least partially fill via holes formed in the circuit board, said droplets passing through an operating zone located between the deposition apparatus and the
15 surface; and

during droplet deposition, controlling the local environment of the operating zone so as to control the filling of the via holes.

67. A method of forming a relief pattern on a surface, said method comprising the steps
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selectively irradiating a charged roller to selectively remove the charge on portions of the roller;

depositing using droplet deposition apparatus a plurality of droplets on to the charged portions of the roller, said droplets passing through an operating zone located
25 between the deposition apparatus and the roller;

during droplet deposition, controlling the local environment of the operating zone so as to control the structure of the pattern formed on the roller; and

transferring the deposited material from the roller on to a surface to form a relief pattern on said surface.

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68. A method according to Claim 67, wherein the relief pattern formed on the surface is subsequently heated to effect material coalescence.

69. A method according to Claim 67, wherein the relief pattern formed on the surface is subsequently subjected to radiation curing to effect material coalescence.

5 70. A method according to any of Claims 67 to 69, wherein the relief pattern comprises an organic electrode.

71. A method according to any of Claims 67 to 69, wherein said relief pattern comprises an opto-electronic device.

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72. A method according to any of Claims 66 to 69, wherein the relief pattern comprises a masking pattern.

73. Droplet deposition apparatus comprising a deposition chamber for housing
15 deposition material, an outlet nozzle in fluid communication with said deposition chamber, means for ejecting droplets of deposition material from said deposition chamber through said outlet nozzle on to a surface, means for defining an operating zone through which droplets pass between the outlet nozzle and the surface, and means for controlling the local environment of the operating zone during deposition to control the formation of a feature
20 on the surface.

74. A method of forming a masking pattern on a surface substantially as herein described.

25 75. A method of forming a spacer pattern on a surface substantially as herein described.

76. A method of forming a circuit pattern on a circuit board substantially as herein described.

30 77. A method of forming a relief pattern on a surface substantially as herein described.

78. Droplet deposition apparatus substantially as herein described.